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(71)Applicant : ALPS ELECTRIC CO LTD

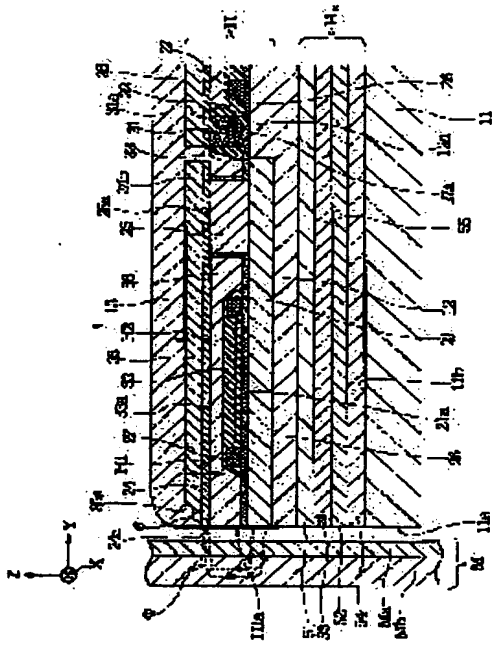
(72)Inventor : TAKAHASHI TORU
YAZAWA HISAYUKI
GOCHO HIDENORI
KOBAYASHI KIYOSHI
YAMADA MINORU
SATO KIYOSHI
WATANABE TOSHINORI

(54) PERPENDICULAR MAGNETIC RECORDING HEAD, AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a perpendicular magnetic recording head capable of suppressing the occurrence of side fringing on a recording pattern, forming a main magnetic pole layer with high pattern accuracy, forming the film of a yoke layer to be thick, and increasing passing efficiency, and its manufacturing method.

SOLUTION: A main magnetic pole layer 24 is formed on a flat insulated layer 33 and, separately from the main magnetic pole layer 24, a thick yoke layer 35 is laminated on the main magnetic pole layer 24. The front end surface 24a of the main magnetic pole layer 24 is formed in such a shape that a width dimension in a track width direction is increased as it is farther away from an auxiliary magnetic pole layer 21. Thus, a perpendicular magnetic recording head is provided, which is capable of suppressing the occurrence of fringing on a recording pattern, forming the main magnetic pole layer with high pattern accuracy, and properly guiding a recording magnetic field to the tip of the main magnetic pole layer.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
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CLAIMS

[Claim(s)]
[Claim 1] By a record field being given to said auxiliary magnetic pole layer and said main pole layer from the coil layer which the auxiliary magnetic pole layer, the insulating layer formed on said auxiliary magnetic pole layer, and the main pole layer formed on said insulating layer were prepared, and was laid underground in said insulating layer In the vertical-magnetic-recording head which records magnetic data on a record medium by the vertical field concentrated on said main pole layer Said main pole layer is formed on a flattening side, and the front end side of said main pole layer is located in an opposed face with a record medium. It is formed in the configuration in which the width method to the truck cross direction spreads as said front end side separates from said auxiliary magnetic pole layer. And the width method of the truck cross direction of the top face of said front end side is regulated as the width of recording track Tw. It is formed by thickness thicker than the thickness of said main pole layer, and the cross section in a cross section parallel to said opposed face is larger than the area of the front end side of said main pole layer. And the vertical-magnetic-recording head to which the yoke layer to which a front end side is located in a back side rather than said opposed face is characterized by connecting with said main pole layer and magnetic target.
[Claim 2] It is the vertical-magnetic-recording head according to claim 1 by which the connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed, said main pole layer is formed on said insulating layer by which flattening was carried out, said yoke layer is piled up and formed on said main pole layer, and the end face section of said main pole layer or the end face section of said yoke layer is magnetically connected to said connection layer.
[Claim 3] It is the vertical-magnetic-recording head according to claim 2 by which the 2nd insulating layer is formed in the perimeter of said main pole layer, the top face of this 2nd insulating layer and the top face of a main pole layer are formed on the same flat surface, and a yoke layer is formed on said flat surface.
[Claim 4] Said main pole layer top is a vertical-magnetic-recording head according to claim 2 with which it is covered by the 3rd insulating layer except for the end face section top of said main pole layer and by which said yoke layer is magnetically connected on said end face section.
[Claim 5] The connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed. Said main pole layer It is formed on said insulating layer by which flattening was carried out, and the end face section is located in said opposed face side rather than said connection layer. The vertical-magnetic-recording head according to claim 1 with which it was formed on said insulating layer, the front end side connected with the back end side of said main pole layer magnetically, and the end face section of said yoke layer has also connected said yoke layer magnetically on said connection layer.
[Claim 6] The connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed. Said yoke layer is formed on said insulating layer by which flattening was carried out, and the end face section connects it magnetically on said connection layer. Moreover, it is the vertical-magnetic-recording head according to claim 1 which the 4th insulating layer is formed between the front end side of said yoke layer, and said opposed face, and flattening of this the 4th top face and said yoke layer top face of an insulating layer is carried out, and piles up a main pole layer with said yoke layer on said flattening side, and is formed.
[Claim 7] The connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed. A magnetic material layer is formed on said insulating layer by which flattening was carried out, and said magnetic material layer consists of a front field formed by predetermined die length towards the height direction from said opposed face, and a back field formed

towards the height direction back from the end face of said front field. It is the vertical-magnetic-recording head according to claim 1 from which the end face section of said back field is magnetically connected to said connection layer, the thickness of said front field is thinly formed compared with the thickness of said back field, said front field serves as said main pole layer, and said back field serves as said yoke layer.
[Claim 8] Said front end side of said yoke layer put on said main pole layer or on the bottom is a vertical-magnetic-recording head given in either of claims 2, 3, 4, and 6 currently formed in respect of the inclined plane which inclines in the height direction therefore it separates from said main pole layer, or the bow.
[Claim 9] The both-sides edge side of the truck cross direction of said front end side of said main pole layer is an inclined plane or a vertical-magnetic-recording head according to claim 1 to 8 currently formed in respect of the bow.
[Claim 10] The manufacture approach of the vertical-magnetic-recording head characterized by having the following processes.
(a) It is the process which forms an auxiliary magnetic pole layer with a magnetic material, and on the (b) aforementioned auxiliary magnetic pole layer. The process which fills said coil layer top by the insulating layer after forming a connection layer in a back side and then forming a coil layer through an insulating substrate layer between said opposed faces and connection layers on said auxiliary magnetic pole layer rather than an opposed face with a record medium, (c) The process which deletes the front face of said insulating layer and makes the same side said insulating-layer top face and said connection layer top face, (d) The process which forms a resist layer on said insulating layer and a connection layer, next keeps spreading at least as the inside width method of the truck cross direction in said opposed face separates from said auxiliary magnetic pole layer, and forms a pattern in said resist layer, (e) The process which removes said resist layer after carrying out plating formation of the main pole layer into the aforementioned omission pattern, (f) It forms on said insulating layer from on said main pole layer, applying the resist layer of thickness thicker than said main pole layer. Rather than said opposed face, the yoke layer located in a back side extracts in said resist layer, and a front end side forms a pattern on said main pole layer at it. Or the process which removes said resist layer after being on said insulating layer, forming towards the height direction from the back end side of said main pole layer and carrying out plating formation of the yoke layer into the aforementioned omission pattern.
[Claim 11] The manufacture approach of a vertical-magnetic-recording head according to claim 10 of replacing with the aforementioned (f) process and having the following processes.
(g) The process which forms the 2nd insulating layer in the perimeter of said main pole layer, and forms the top face of said 2nd insulating layer, and the top face of said main pole layer on the same side, (h) It forms on said 2nd insulating layer from on said main pole layer, applying the resist layer of thickness thicker than said main pole layer. The process which removes said resist layer after the yoke layer to which a front end side is located in a back side rather than said opposed face extracting in said resist layer, forming a pattern on said main pole layer and the 2nd insulating layer and carrying out plating formation of the yoke layer into the aforementioned omission pattern.
[Claim 12] The manufacture approach of a vertical-magnetic-recording head according to claim 10 of replacing with the aforementioned (f) process and having the following processes.
(i) The process which applies on said insulating layer from on said main pole layer, and forms the 3rd insulating layer, (j) The process which forms a hole in said 3rd insulating layer formed on the end face section of said main pole layer at least, (k) Process which removes said resist layer after the yoke layer located in a back side rather than said opposed face extracting, and a front end side's forming a pattern after forming the resist layer of thickness thicker than said main pole layer on said 3rd insulating layer, and carrying out plating formation of the yoke layer into the aforementioned omission pattern.
[Claim 13] The manufacture approach of a vertical-magnetic-recording head according to claim 10 of replacing with the aforementioned (d) process thru/or the (f) process, and having the following processes.
(l) The process which removes said resist layer after forming a resist layer on said insulating layer, and the yoke layer to which a front end side is located in a back side rather than said opposed face extracting, forming a pattern and carrying out plating formation of the yoke layer into the aforementioned omission pattern, (m) The process which newly forms the 4th insulating layer on said yoke layer and said insulating layer, deletes said 4th insulating layer, and makes the same field the top face of said 4th insulating layer, and the top face of said yoke layer, (n) The resist layer of thickness thinner than said yoke layer is formed on said yoke layer and the 4th insulating layer. The process which it applies to the resist layer on said yoke layer from the resist layer on the 4th [said] insulating layer located in an opposed face side, and a main pole layer extracts, and forms a pattern rather than the front end side of said yoke layer, and the process

which removes said resist layer after carrying out plating formation of the main pole layer into the (o) aforementioned omission pattern.
[Claim 14] The manufacture approach of a vertical-magnetic-recording head according to claim 10 of replacing with the aforementioned (d) process thru/or the (f) process, and having the following processes. A resist layer is formed [next] on said insulating layer and a connection layer. At least (p) The inside width method of the truck cross direction in said opposed face The process which keeps spreading as it separates from said auxiliary magnetic pole layer, forms a pattern in said resist layer, and forms the end face section of the aforementioned omission pattern even on said connection layer further, (q) The process which removes said resist layer after carrying out plating formation of the magnetic material layer into the aforementioned omission pattern, (r) Form a resist layer on said magnetic material layer, and extract only predetermined distance in the height direction from the opposed face side on said magnetic material layer by exposure development, and a pattern is formed. The process which removes said a part of magnetic material layer exposed out of the aforementioned omission pattern, makes thickness thin, uses this part as a main pole layer, and uses as a yoke layer the magnetic material layer formed in the bottom of said resist layer.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention can form a main pole layer with a sufficient pattern precision while controlling that start the vertical-magnetic-recording head which records by giving a vertical field to record media, such as a disk which has a hard side, especially fringing occurs to a record pattern, and it can form the thickness of a yoke layer thickly, and aims at offering the vertical-magnetic-recording head which can raise passage effectiveness, and its manufacture approach.
[0002]
[Description of the Prior Art] There is vertical magnetic recording as equipment which records magnetic data on record media, such as a disk, by high density. Drawing 38 is the sectional view showing the general structure of the vertical-magnetic-recording head used for the equipment of said vertical magnetic recording.

[0003] As shown in drawing 38 , the vertical-magnetic-recording head H of vertical magnetic recording is formed in the side edge side of the slider 1 which moves [surfaces it and] or slides on a record-medium top, and said vertical-magnetic-recording head H is arranged between a nonmagnetic membrane 2 and the nonmagnetic coat film 3 in side edge side 1a of a slider 1.
[0004] Said vertical-magnetic-recording head H has the auxiliary magnetic pole layer 4 formed with the ferromagnetic ingredient, and the main pole layer 5 which opened spacing and was formed on said auxiliary magnetic pole layer 4 and which was similarly formed with the ferromagnetic ingredient, and end-face 4a of said auxiliary magnetic pole layer 4 and end-face 5a of said main pole layer 5 have appeared in the opposed face Ha with a record medium M. In the back side, said auxiliary magnetic pole layer 4 and said main pole layer 5 are magnetically connected in the magnetic connection 6 rather than said opposed face Ha.
[0005] Between said auxiliary magnetic pole layers 4 and said main pole layers 5, the nonmagnetic insulating layer 7 by inorganic materials, such as aluminum2O3 and SiO2, is located, and end-face 7a of this nonmagnetic insulating layer 7 has appeared in said opposed face Ha between end-face 4a of said auxiliary magnetic pole layer 4, and end-face 5a of said main pole layer 5.
[0006] And in said nonmagnetic insulating layer 7, the coil layer 8 formed with conductive ingredients, such as Cu, is laid underground.
[0007] As shown in drawing 38 , the thickness hw of end-face 5a of the main pole layer 5 is smaller than the thickness hr of end-face 4a of the auxiliary magnetic pole layer 4. Moreover, the width method of end-face 5a of the truck cross direction (the direction of graphic display X) of said main pole layer 5 is the width of recording track Tw, and this width method is smaller enough than the width method of end-face 4a of the truck cross direction of said auxiliary magnetic pole layer 4.
[0008] The record medium M to which magnetic recording is performed by said vertical-magnetic-recording head H moves to a Z direction to the vertical-magnetic-recording head H, and the software side Mb is established for the hard side Ma in the front face in the inner direction.
[0009] When a record field is guided to the auxiliary magnetic pole layer 4 and the main pole layer 5 by energizing in said coil layer 8, the leakage record field between end-face 4a of the auxiliary magnetic pole layer 4 and end-face 5a of the main pole layer 5 passes through the hard side Ma of a record medium M vertically, and passes along the software side Mb. Here, since the area of end-face 5a of the main pole layer 5 is smaller enough than the area in end-face 4a of the auxiliary magnetic pole layer 4 as mentioned above, magnetic flux phi concentrates in the opposite part of end-face 5a of the main pole layer 5, and magnetic data are recorded by said magnetic flux phi to said hard side Ma in the part which end-face 5a counters.
[0010]

[Problem(s) to be Solved by the Invention] However, the following troubles occurred with the conventional vertical-magnetic-recording head H shown in drawing 38 .
[0011] (1) With the structure shown in drawing 38 , ****** has occurred on the top face of said nonmagnetic insulating layer 7, and the pattern precision of the main pole layer 5 formed on this falls. It is required to make small area of end-face 5a of said main pole layer 5 which has appeared in said opposed face Ha especially, to leak, and to centralize a record field, and in order to attain the high recording density to a record medium M, it is necessary to narrow the width of recording track Tw of said end-face 5a.
[0012] Therefore, in drawing 38 , it cannot become difficult to narrow-track-ize the width of recording track Tw of end-face 5a of said main pole layer 5 with a sufficient pattern precision, and to form it, and it cannot respond to high recording density-ization appropriately.
[0013] (2) In order to lead the field guided from said coil layer 8 to an opposed face Ha, in the field by the side of the back of said main pole layer 5, it is required to make large the cross section which passes magnetic flux. however, with the structure shown in drawing 38 , the thickness of said main pole layer 5 cannot be formed by the thickness carried out about 1 law, having applied to the height direction (direction of graphic display Y) back, therefore cannot enlarge thickness of said main pole layer 5 in a back side field, and cannot draw the induction field from said coil layer 8 at the head of said main pole layer 5 effectively.
[0014] (3) Like drawing 38 , when formed by the film with said single main pole layer 5, it is difficult to make extremely small only the width of recording track Tw of said end-face 5a of said main pole layer 5. That is, it is difficult to make the width method of the aforementioned omission pattern extremely small only in the part which extracts in a resist layer, forms a pattern, and forms end-face 5a when [that] extracting, forming a magnetic material by plating etc. in a pattern and forming said main pole layer 5.
[0015] (4) In case a slider 1 moves between the periphery of the disk-like record medium M, and inner circumference, the angle of skew to which end-face 5a of said main pole layer 5 inclines to the revolution tangential direction (graphic display Z direction) of a record medium M may occur. If end-face 5a of the main pole layer 5 has an angle of skew to the revolution tangential direction (graphic display Z direction) of a record medium as end-face 5a of the main pole layer 5 is a square or a rectangle as shown in drawing 39 here, as a broken line shows, side side 5b of a main pole layer will give a slanting leakage field into the width of recording track Tw1, Fringing F will occur, and off-track performance degradation will be caused.
[0016] Then, this invention solves the above-mentioned conventional technical problem, and it aims at offering the vertical-magnetic-recording head which can respond the end face of said main pole layer with a sufficient pattern precision to narrow track-ization, and its manufacture approach.
[0017] Moreover, this invention can enlarge effectively thickness in the back side field of said main pole layer, and aims at offering the vertical-magnetic-recording head which can draw the magnetic flux guided from the coil layer suitable for the end face of said main pole layer, and its manufacture approach.
[0018] Moreover, this invention can control that fringing occurs to a record pattern, and aims at offering the vertical-magnetic-recording head which can aim at improvement in the off-track engine performance, and its manufacture approach.
[0019]
[Means for Solving the Problem] The insulating layer by which this invention was formed on the auxiliary magnetic pole layer and said auxiliary magnetic pole layer, By a record field being given to said auxiliary magnetic pole layer and said main pole layer from the coil layer which the main pole layer formed on said insulating layer was prepared, and was laid underground in said insulating layer In the vertical-magnetic-recording head which records magnetic data on a record medium by the vertical field concentrated on said main pole layer Said main pole layer is formed on a flattening side, and the front end side of said main pole layer is located in an opposed face with a record medium. It is formed in the configuration in which the width method to the truck cross direction spreads as said front end side separates from said auxiliary magnetic pole layer. And the width method of the truck cross direction of the top face of said front end side is regulated as the width of recording track Tw. It is formed by thickness thicker than the thickness of said main pole layer, and the cross section in a cross section parallel to said opposed face is larger than the area of the front end side of said main pole layer, and the yoke layer to which a front end side is located in a back side rather than said opposed face is characterized by connecting with said main pole layer and magnetic target.
[0020] In above-mentioned this invention, said main pole layer is formed on the insulating layer by which flattening was carried out. Therefore, said main pole layer can be formed with a sufficient pattern precision, and narrow track-ization of said end face of said main pole layer can be attained especially appropriately.
[0021] Moreover, it is possible to be able to control appropriately that fringing occurs to a record pattern,

and to aim at improvement in an off-track property by forming the dimension of the truck cross direction of the front end side of said main pole layer in this invention in the configuration which spreads gradually as it separates from said auxiliary magnetic pole layer.

[0022] Moreover, in this invention, by connecting the large yoke layer of thickness to said main pole layer magnetically rather than said main pole layer, magnetic flux can be effectively drawn in said main pole layer from said yoke layer, and passage effectiveness becomes good and can improve an over-writing property.

[0023] In this invention, the vertical-magnetic-recording head of concrete structure as shown below can be offered.

[0024] First, by this invention, the connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed, said main pole layer is formed on said insulating layer by which flattening was carried out, said yoke layer is piled up and formed on said main pole layer, and the end face section of said main pole layer or the end face section of said yoke layer is magnetically connected to said connection layer. This operation gestalt is drawing 1 .

[0025] Moreover, it is desirable that the 2nd insulating layer is formed in the perimeter of said main pole layer, the top face of this 2nd insulating layer and the top face of a main pole layer are formed on the same flat surface, and a yoke layer is formed on said flat surface in this invention. This operation gestalt is drawing 1111 and drawing 12 .

[0026] Moreover, as for said main pole layer top, in this invention, it is desirable that it is covered except for the end face section top of said main pole layer at the 3rd insulating layer, and said yoke layer is magnetically connected on said end face section. This operation gestalt is drawing 5 .

[0027] In this invention, the connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed. Or said main pole layer It was formed on said insulating layer by which flattening was carried out, and the end face section connected magnetically [the front end side] to the back end side of said main pole layer by having formed said yoke layer on said insulating layer by being located in said opposed face side rather than said connection layer, and the end face section of said yoke layer has connected magnetically on said connection layer. This operation gestalt is drawing 2 .

[0028] Or in this invention, the connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed. Said yoke layer is formed on said insulating layer by which flattening was carried out, and the end face section connects it magnetically on said connection layer. Moreover, the 4th insulating layer is formed between the front end side of said yoke layer, and said opposed face, and flattening of this the 4th top face and said yoke layer top face of an insulating layer is carried out, and on said flattening side, a main pole layer is piled up with said yoke layer, and is formed. This operation gestalt is drawing 3 and drawing 4 .

[0029] Or in this invention, the connection layer which starts from on said auxiliary magnetic pole layer by the back side rather than said opposed face is formed. A magnetic material layer is formed on said insulating layer by which flattening was carried out, and said magnetic material layer consists of a front field formed by predetermined die length towards the height direction from said opposed face, and a back field formed towards the height direction back from the end face of said front field. The end face section of said back field is magnetically connected to said connection layer, the thickness of said front field is thinly formed compared with the thickness of said back field, said front field serves as said main pole layer, and said back field serves as said yoke layer. This operation gestalt is drawing 6 .

[0030] Moreover, therefore said front end side of said yoke layer put on said main pole layer or on the bottom in this invention separates from said main pole layer, it is desirable to be formed in respect of the inclined plane which inclines in the height direction, or a bow.

[0031] As for the both-sides edge of the truck cross direction of said front end side of said main pole layer, in this invention, it is still more desirable to be formed in respect of an inclined plane or a bow.

[0032] Next, the manufacture approach of the vertical-magnetic-recording head in this invention is characterized by having the following processes.

(a) It is the process which forms an auxiliary magnetic pole layer with a magnetic material, and on the (b) aforementioned auxiliary magnetic pole layer. The process which fills said coil layer top by the insulating layer after forming a connection layer in a back side and then forming a coil layer through an insulating substrate layer between said opposed faces and connection layers on said auxiliary magnetic pole layer rather than an opposed face with a record medium, (c) The process which deletes the front face of said insulating layer and makes the same side said insulating-layer top face and said connection layer top face, (d) The process which forms a resist layer on said insulating layer and a connection layer, next keeps spreading at least as the inside width method of the truck cross direction in said opposed face separates from

said auxiliary magnetic pole layer, and forms a pattern in said resist layer, (e) The process which removes said resist layer after carrying out plating formation of the main pole layer into the aforementioned omission pattern, (f) It forms on said insulating layer from on said main pole layer, applying the resist layer of thickness thicker than said main pole layer. Rather than said opposed face, the yoke layer located in a back side extracts in said resist layer, and a front end side forms a pattern on said main pole layer at it. Or the process which removes said resist layer after being on said insulating layer, forming towards the height direction from the back end side of said main pole layer and carrying out plating formation of the yoke layer into the aforementioned omission pattern.

[0033] By the above-mentioned manufacture approach, the vertical-magnetic-recording head shown in drawing 1 or drawing 2 can be manufactured.

[0034] Or in this invention, it may replace with the aforementioned (f) process and you may have the following processes.

(g) The process which forms the 2nd insulating layer in the perimeter of said main pole layer, and forms the top face of said 2nd insulating layer, and the top face of said main pole layer on the same side, (h) It forms on said 2nd insulating layer from on said main pole layer, applying the resist layer of thickness thicker than said main pole layer. The process which removes said resist layer after the yoke layer to which a front end side is located in a back side rather than said opposed face extracting in said resist layer, forming a pattern on said main pole layer and the 2nd insulating layer and carrying out plating formation of the yoke layer into the aforementioned omission pattern.

[0035] The vertical-magnetic-recording head shown in drawing 11 and drawing 12 by this manufacture approach can be manufactured.

[0036] Or in this invention, it may replace with the aforementioned (f) process and you may have the following processes.

(i) The process which applies on said insulating layer from on said main pole layer, and forms the 3rd insulating layer, (j) The process which forms a hole in said 3rd insulating layer formed on the end face section of said main pole layer at least, (k) Process which removes said resist layer after the yoke layer located in a back side rather than said opposed face extracting, and a front end side's forming a pattern after forming the resist layer of thickness thicker than said main pole layer on said 3rd insulating layer, and carrying out plating formation of the yoke layer into the aforementioned omission pattern.

[0037] The vertical-magnetic-recording head shown in drawing 5 by this manufacture approach can be manufactured. Moreover, in this invention, it may replace with the aforementioned (d) process thru/or the (f) process, and you may have the following processes.

(l) The process which removes said resist layer after forming a resist layer on said insulating layer, and the yoke layer to which a front end side is located in a back side rather than said opposed face extracting, forming a pattern and carrying out plating formation of the yoke layer into the aforementioned omission pattern, (m) The process which newly forms the 4th insulating layer on said yoke layer and said insulating layer, deletes said 4th insulating layer, and makes the same field the top face of said 4th insulating layer, and the top face of said yoke layer, (n) The resist layer of thickness thinner than said yoke layer is formed on said yoke layer and the 4th insulating layer. The process which it applies to the resist layer on said yoke layer from the resist layer on the 4th [said] insulating layer located in an opposed face side, and a main pole layer extracts, and forms a pattern rather than the front end side of said yoke layer, and the process which removes said resist layer after carrying out plating formation of the main pole layer into the (o) aforementioned omission pattern.

[0038] The vertical-magnetic-recording head shown in drawing 3 or drawing 4 by this manufacture approach can be manufactured.

[0039] Or in this invention, it may replace with the aforementioned (d) process thru/or the (f) process, and you may have the following processes.

A resist layer is formed [next] on said insulating layer and a connection layer. At least (p) The inside width method of the truck cross direction in said opposed face The process which keeps spreading as it separates from said auxiliary magnetic pole layer, forms a pattern in said resist layer, and forms the end face section of the aforementioned omission pattern even on said connection layer further, (q) The process which removes said resist layer after carrying out plating formation of the magnetic material layer into the aforementioned omission pattern, (r) Form a resist layer on said magnetic material layer, and extract only predetermined distance in the height direction from the opposed face side on said magnetic material layer by exposure development, and a pattern is formed. The process which removes said a part of magnetic material layer exposed out of the aforementioned omission pattern, makes thickness thin, uses this part as a main

pole layer, and uses as a yoke layer the magnetic material layer formed in the bottom of said resist layer.
[0040] The vertical-magnetic-recording head shown in drawing 6 by this manufacture approach can be manufactured.
[0041]
[Embodiment of the Invention] Drawing 1 is drawing of longitudinal section showing the structure of the vertical-magnetic-recording head of the 1st operation gestalt of this invention.
[0042] The vertical-magnetic-recording head H shown in drawing 1 gives a vertical field to a record medium M, and makes the hard side Ma of a record medium M magnetize perpendicularly.
[0043] Said record medium M is a disk-like, and the high hard side Ma of residual magnetization has the software side Mb where magnetic transmission is high in the inner direction, and the core of a disk takes the revolving-shaft lead and it is rotated for it by the front face.
[0044] If it is formed with ceramic ingredients, such as aluminum 2O3 and TiC, opposed face 11a of a slider 11 counters said record medium M and a record medium M rotates, a slider 11 will surface from the front face of a record medium M by surface airstream, or a slider 11 will slide on the slider 11 of said vertical-magnetic-recording head H at a record medium M. In drawing 1 , the migration direction of the record medium M to a slider 11 is a graphic display Z direction. The vertical-magnetic-recording head H is formed in the trailing side edge side of a slider 11.
[0045] The nonmagnetic insulating layer 54 by inorganic materials, such as aluminum 2O3 or SiO2, is formed in side edge side 11b of said slider 11, and read station HR is formed on this nonmagnetic insulating layer 54.
[0046] Said reading section HR consists of the lower shielding layer 52 from the bottom, the gap layer 55, the magneto-resistive effect component 53, and the up shielding layer 51. Said magneto-resistive effect components 53 are an anisotropy magneto-resistive effect (AMR) component, a giant magneto-resistance (GMR) component, a tunnel mold magneto-resistive effect (TMR) component, etc.
[0047] On said up shielding layer 51, the nonmagnetic insulating layer 12 by inorganic materials, such as aluminum 2O3 or SiO2, is formed, and the vertical-magnetic-recording head H for record of this invention is formed on said nonmagnetic insulating layer 12. And the vertical-magnetic-recording head H is covered with the protective layer 13 formed by the inorganic nonmagnetic insulating material etc. And opposed face H1a with the record medium of said vertical-magnetic-recording head H is the same side mostly with opposed face 11a of said slider 11.
[0048] With said vertical-magnetic-recording head H, said nonmagnetic insulating layer 12 in which ferromagnetic ingredients, such as a permalloy (nickel-Fe), are plated and the auxiliary magnetic pole layer 21 is formed is formed in the bottom of said auxiliary magnetic pole layer 21 (between the auxiliary magnetic pole layer 21 and side edge side 11b of a slider 11), and the perimeter of said auxiliary magnetic pole layer 21. And as shown in drawing 1 , surface (top face) 21a of the auxiliary magnetic pole layer 21 and surface (top face) 12a of said nonmagnetic insulating layer 12 are located on the same flat surface.
[0049] As shown in drawing 1 , by the back side (the height direction, the direction of graphic display Y), the connection layers 25, such as nickel-Fe, are formed on surface 21a of said auxiliary magnetic pole layer 21 rather than said opposed face H1a.
[0050] In the perimeter of said connection layer 25, the nonmagnetic insulating layers 26, such as aluminum 2O3, are formed on surface 21a of said auxiliary magnetic pole layer 21, and surface 12a of said nonmagnetic insulating layer 12, and the coil layer 27 is formed with conductive ingredients, such as Cu, on this nonmagnetic insulating layer 26. This coil layer 27 is formed with frame plating etc., and pattern formation is spirally carried out so that it may become a predetermined number of turns around said connection layer 25. On end-connection 27a by the side of the volume core of the coil layer 27, the bottom raising layer 31 similarly formed with conductive ingredients, such as Cu, is formed.
[0051] Said coil layer 27 and the bottom raising layer 31 are covered with the insulating layer 32 of organic materials, such as a resist ingredient, and are further covered by the insulating layer 33.
[0052] As for said insulating layer 33, being formed by the inorganic insulating material is desirable, and at least one or more sorts in AlO, aluminum 2O3, SiO2 and Ta 2O5, TiO and AlN, AlSiN, TiN and SiN, Si3N4, NiO, WO, WO3, BN and CrN, and SiON can be chosen as said inorganic insulating material.
[0053] And surface (top face) 25a of said connection layer 25, surface (top face) 31a of the bottom raising layer 31, and surface (top face) 33a of an insulating layer 33 are processed so that it may become the same side. Such flattening processing is performed using a CMP (chemical mechanical polishing) technique etc. so that it may explain by the below-mentioned manufacture approach.
[0054] With this 1st operation gestalt, the main pole layer 24 is formed on said insulating layer 33, and front

end side 24a of said main pole layer 24 is made into the same field as said opposed face H1a. Moreover, it was formed on top-face 25a of said connection layer 25, and end face section 24b of said main pole layer 24 has connected magnetically.

[0055] As shown in drawing 1 , the yoke layers 35, such as a NiFe alloy, are piled up and formed on said main pole layer 24. Moreover, rather than said opposed face H1a, front end side 35a of said yoke layer 35 was located in the height direction back side, is buried in said protective layer 13, and has not appeared in opposed face H1a.

[0056] In addition, in this invention, the thickness H2 of said yoke layer 35 is formed more thickly than the thickness H1 of the main pole layer 24.

[0057] Moreover, front end side 35a of said yoke layer 35 is formed in respect of the inclined plane which inclines in the height direction (the direction of graphic display Y) towards a top face from an underside, or the bow. As for the underside of the main pole layer 24 formed on said yoke layer 35, and the exterior angle theta between front end side 35a of said yoke layer 35, it is desirable that it is 90 degrees or more. It is because the field which leaks from said main pole layer 24 towards said yoke layer 35 by this can be lessened and a field can be centralized by said main pole layer 24.

[0058] Moreover, as shown in drawing 1 , the lead layer 36 is formed in surface 31a of said bottom raising layer 31, and supply of a record current is possible in said bottom raising layer 31 and the coil layer 27 from the lead layer 36. In addition, it can form with the same ingredient as said main pole layer 24 and the yoke layer 35, and said lead layer 36 can form simultaneously the main pole layer 24 and the yoke layer 35, and the lead layer 36 by plating. And said yoke layer 35 and said lead layer 36 are covered with said protective layer 13.

[0059] The top view (the direction of an arrow head) which looked at the vertical-magnetic-recording head shown in drawing 1 from right above is shown like drawing 10 . As shown in the top view of drawing 10 , narrow-width front field 24c in which the top face (field by the side of trailing of the main pole layer 24) of front end side 24a is formed in with the minute width of recording track Tw, and said main pole layer 24 maintains this width method at, or a width method spreads a little is formed. Moreover, from the end face of this front field 24c, 24d of back fields is formed, and the dimension of the truck cross direction is gradually spread and formed in the target at 24d of said back end fields.

[0060] As shown in drawing 10 , said yoke layer 35 is piled up and formed on 24d of back end fields of said main pole layer 24. Said yoke layer 35 is formed in the configuration to which the width method to the truck cross direction spreads on a target gradually towards the height direction back.

[0061] In addition, in this invention, it is required for front end side 24a of said main pole layer 24 exposed to said opposed face H1a to be larger than the area of front end side 21b of said auxiliary magnetic pole layer 21, for example, as shown in drawing 10 , it is desirable [the width method Wr of the truck cross direction of the auxiliary magnetic pole layer 21] to be formed by the width method larger enough than said width of recording track Tw.

[0062] In addition, it does not pass over the configuration shown in drawing 10 to an example, and this invention is not limited to this configuration. Namely, in this invention, the area of the cross section which is when cutting said yoke layer 35 from a direction parallel to said opposed face H1a should just become larger than the area of front end side 24a of said main pole layer 24.

[0063] However, it is desirable comparable [as the dimension of the 24d / of back end fields of said main pole layer 24 / truck cross direction] or to form the width method to the truck cross direction (the direction of graphic display X) of said yoke layer 35 by the width method smaller than it with the structure shown in drawing 10 . It is because pattern precision may fall and said yoke layer 35 may be unable to be appropriately formed with a predetermined configuration in the part in which said yoke layer 35 is formed crosswise [truck] by overflowing rather than the main pole layer 24 of the level difference between said main pole layers 24 and insulating layers 33.

[0064] As it corrects, for example, is shown in drawing 11 (front view), the 2nd insulating layer 56 and 56 is newly formed in the both sides of the truck cross direction (the direction of graphic display X) of said main pole layer 24. When processing top-face 24e of said main pole layer 24, and top-face 56a of said 2nd insulating layer 56 on the same flat surface using a CMP technique etc. and forming said yoke layer 35 on it, as shown in drawing 12 (top view) It becomes possible to protrude and form said yoke layer 35 rather than the width method of the truck cross direction of the main pole layer 24. In this case, the yoke layer 35 formed on it can be formed with a sufficient pattern precision by flattening of top-face 24e of said main pole layer 24 and the top-face 56a of the 2nd insulating layer 56 being carried out appropriately.

[0065] In addition, as for said 2nd insulating layer 56, being formed by the inorganic insulating material is

desirable, and at least one or more sorts in AlO, aluminum 2O3, SiO2 and Ta 2O5, TiO and AlN, AlSiN, TiN and SiN, Si3N4, NiO, WO, WO3, BN and CrN, and SiON can be chosen as said inorganic insulating material.

[0066] Moreover, although said main pole layer 24 is extended and formed even on said connection layer 25 from said opposed face H1a with the operation gestalt shown in drawing 1 , said main pole layer 24 is formed short, for example, and you may form so that the end face section may be located in said opposed face H1a side rather than said connection layer 25.

[0067] In this case, the 2nd insulating layer 56 shown in drawing 1111 is formed in the perimeter of said main pole layer 24, and the yoke layer 35 is formed on this. Moreover, a hole is formed on said connection layer 25, plating formation of said yoke layer 35 is carried out also into this hole, and said yoke layer 35 and connection layer 25 are magnetically connected to said 2nd insulating layer 56.

[0068] Drawing 2 is drawing of longitudinal section showing the structure of the vertical-magnetic-recording head of the 2nd operation gestalt in this invention.

[0069] The point of difference with drawing 1 is in the structure of the main pole layer 24 and the yoke layer 35. Although the point currently formed more thickly than the thickness H3 of said main pole layer 24 has the the same thickness H4 of said yoke layer 35 Said main pole layer 24 is short formed in the height direction (the direction of graphic display Y) from opposed face H1a, front end side 35a of said yoke layer 35 connects it magnetically from 24f of back end sides of said main pole layer 24, and said yoke layer 35 is formed on said insulating layer 33 towards the height direction back. And end face section 35b of said yoke layer 35 was formed in top-face 25a of said connection layer 25, and will be connected magnetically.

[0070] Drawing 13 is the top view of the vertical-magnetic-recording head of drawing 2 . The width method to the truck cross direction (the direction of graphic display X) of the top face (field by the side of trailing of the main pole layer 24) of front end side 24a is formed with the minute width of recording track Tw, and said main pole layer 24 is formed in this width method or the narrow-width configuration in which it applies to the height direction (direction of graphic display Y) back from this width method, and a width method spreads a little. In addition, as shown in drawing 13 , 24d of back end fields where the width method to the truck cross direction spreads on a target gradually towards the height direction back may be formed in said main pole layer 24.

[0071] Said yoke layer 35 is formed from 24f of back end sides of said main pole layer 24, and towards the height direction back, gradually, the width method to the truck cross direction spreads on a target, and, as for said yoke layer 35, is formed.

[0072] In addition, it does not pass over the configuration shown in drawing 13 to an example, and this invention is not limited to this configuration. Namely, in this invention, the area of the cross section which is when cutting said yoke layer 35 from a direction parallel to said opposed face H1a should just become larger than the area of front end side 24a of said main pole layer.

[0073] Drawing 3 is drawing of longitudinal section showing the structure of the vertical-magnetic-recording head of the 3rd operation gestalt in this invention.

[0074] The point of difference with drawing 1 is in the structure of the main pole layer 24 and the yoke layer 35. Although the thickness H6 of the yoke layer 35 is large compared with the thickness H5 of said main pole layer 24 also with this operation gestalt, said yoke layer 35 is formed on said insulating layer 33, and end face section 35b of said yoke layer 35 is magnetically connected to top-face 25a of said connection layer 25.

[0075] Moreover, front end side 35a of said yoke layer 35 is formed in respect of the inclined plane which approaches said opposed face H1a towards a top face from an underside, or the bow. As for the underside of the main pole layer 24 formed on said yoke layer 35, and the exterior angle theta between front end side 35a of said yoke layer 35, it is desirable that it is 90 degrees or more. It is because the field which leaks from said main pole layer 24 towards said yoke layer 35 by this can be lessened and a field can be centralized by said main pole layer 24.

[0076] As shown in drawing 3 , the perimeter of said yoke layer 35 is filled by the 4th new insulating layer 57. In addition, as shown in drawing 3 , from front end side 35a of the yoke layer 35, in the opposed face H1a side, it is buried by said 4th insulating layer 57, and said 4th insulating layer 57 appears from said opposed face H1a. In this invention, flattening processing has accomplished the top face of said 4th insulating layer 57, and the top face of said yoke layer 35 using the CMP technique etc.

[0077] As for said 4th insulating layer 57, being formed by the inorganic insulating material is desirable, and at least one or more sorts in AlO, aluminum 2O3, SiO2 and Ta 2O5, TiO and AlN, AlSiN, TiN and SiN, Si3N4, NiO, WO, WO3, BN and CrN, and SiON can be chosen as said inorganic insulating material.

[0078] And in this invention, it applies on the yoke layer 35 from on said said 4th insulating layer 57 by which flattening was carried out, and the main pole layer 24 is formed.
[0079] Drawing 14 is the top view of the vertical-magnetic-recording head shown in drawing 3 . As shown in drawing 14 , flat-surface formation of said yoke layer 35 is carried out at 35d of back end fields in which said width method spreads on a target gradually towards the height direction back from narrow-width front field 35c by which the width method to the truck cross direction was made thin, and this end face.
[0080] In addition, the width method to the truck cross direction of said front field 35c is formed more greatly than the width of recording track Tw.
[0081] As shown in drawing 14 , front end side 24a appears in said opposed face H1a, and the top face of said front end side 24a is formed for the main pole layer 24 formed on said yoke layer 35 from on said 4th insulating layer 57, having applied with the width of recording track Tw. Flat-surface formation of said main pole layer 24 is carried out at 24d of back fields in which the dimension of the width of recording track spreads on a target gradually towards the height direction back from front field 24c which was a truck width method, or was a little broader than it and was formed in the height direction back from said front end side 24a, and said front field 24c.
[0082] In addition, it does not pass over the configuration shown in drawing 14 to an example, and this invention is not limited to this configuration. Namely, in this invention, the area of the cross section which is when cutting said yoke layer 35 from a direction parallel to said opposed face H1a should just become larger than the area of front end side 24a of said main pole layer.
[0083] For example, narrow-width front field 35c may not be formed in said yoke 35, but you may be formed only at 35d of back fields, and gradually, 24d of back fields where a width method spreads on a target is not formed, but as shown by the alternate long and short dash line, a narrow-width field may be extended even back and may be formed in the main pole layer 24.
[0084] Drawing 4 is drawing of longitudinal section showing the structure of the vertical-magnetic-recording head of the 4th operation gestalt in this invention.
[0085] The difference from drawing 3 is only the point that the main pole layer 24 is formed in the height direction back by short die length from said opposed face H1a.
[0086] Drawing 15 is the top view of the vertical-magnetic-recording head shown in drawing 4 . As shown in drawing 15 , it is formed by short die length, main pole applying [said / 24] it on said yoke layer 35 from on the 4th insulating layer 57 made into the same flat side as the top face of said yoke layer 35. The die length of the truck cross direction of the top face of that front end side 24a is formed with the minute width of recording track Tw, and said main pole layer 24 maintains this width method, or becomes a little broader than this width method, and is formed towards the height direction back. It may be formed although narrow-width front field 35c as shown in drawing 14 is not formed in the yoke layer 35 shown in drawing 15 . At drawing 15 , said yoke layer 35 is formed in the configuration to which the width method of the truck cross direction spreads on a target gradually.
[0087] Drawing 16 is another top view of the vertical-magnetic-recording head shown in drawing 4 , and said main pole layer 24 of the difference from drawing 15 is the point that the width method from narrow-width front field 24c and its end face to the truck cross direction consists of 24d of back fields which spread on a target gradually. Installation of the magnetic flux from said yoke layer 35 to the main pole layer 24 can be made good by this, and it is possible to manufacture the vertical recording magnetic head which can attain high recording density-ization effectively.
[0088] In addition, it does not pass over the configuration shown in drawing 15 and drawing 16 to an example, and this invention is not limited to this configuration. Namely, in this invention, the area of the cross section which is when cutting said yoke layer 35 from a direction parallel to said opposed face H1a should just become larger than the area of front end side 24a of said main pole layer.
[0089] Drawing 5 is drawing of longitudinal section showing the structure of the vertical-magnetic-recording head of the 5th operation gestalt in this invention.
[0090] By the vertical-magnetic-recording head and drawing 1 which are shown in drawing 5 , the structures of the main pole layer 24 and the yoke layer 35 differ.
[0091] Although the thickness H8 of the yoke layer 35 is formed also with the structure shown in drawing 5 more greatly than the thickness H7 of the main pole layer 24, said main pole layer 24 is top-face 33a of said insulating layer 33, and is formed in the height direction (direction of graphic display Y) back by short die length from said opposed face H1a. Although its distance is furthermore kept a little in the height direction from the back end side of said main pole layer 24 and the 3rd new insulating layer 58 is formed in piles on said insulating layer 33, said 3rd insulating layer 58 is not formed on said connection layer 25 and the

bottom raising layer 31.
[0092] As for said 58, being formed by the inorganic insulating material is desirable, and at least one or more sorts in AlO, aluminum 2O3, SiO2 and Ta 2O5, TiO and AlN, AlSiN, TiN and SiN, Si3N4, NiO, WO, WO3, BN and CrN, and SiON can be chosen as said inorganic insulating material.
[0093] Moreover, although said a part of 3rd insulating layer 58 is formed also on said main pole layer 24, it is not formed on end face section 24b of said main pole layer 24. Said 3rd insulating layer 58 formed on said main pole layer 24 has the role which protects said main pole layer 24 from etching at the time of removing the plating substrate layer formed in the perimeter of the yoke layer 33 so that it may explain by the below-mentioned manufacture approach.
[0094] The yoke layer 35 is formed on the 3rd insulating layer 58 formed in the height direction back rather than said main pole layer 24. It was formed on end face section 24b of said main pole layer 24 exposed from hole 58a formed in said 3rd insulating layer 58, and the front of said yoke layer 35 has connected with said main pole layer 24 magnetically.
[0095] Front end side 35a of said yoke layer 35 is formed in a back side rather than opposed face H1a, and, in the opposed face H1a side, it will be buried from said front end side 35a by the protective layer 13. Moreover, being formed in respect of the inclined plane which is missing from a top face from an underside, and becomes deep towards the height direction, or a bow can control that a field leaks from said main pole layer 24 to said yoke layer 35, and said front end side 35a has it, as shown in drawing 5 . [desirable]
[0096] As for the exterior angle theta between said front end side 35a and undersides, it is desirable that it is 90 degrees or more. Moreover, it was formed on said connection layer 25, and end face section 35b of said yoke layer 35 has connected magnetically.
[0097] Moreover, the lead layer 36 formed at the same process as said yoke layer 35 is formed on said bottom raising layer 31.
[0098] Drawing 17 is the top view of the vertical-magnetic-recording head shown in drawing 5 . As shown in drawing 17 , said main pole layer 24 consists of 24d of back fields in which the width method from this end face to front field 24c which the width method of the truck cross direction of the top face of front end side 24a is formed with a dimension with the minute width of recording track Tw, and maintains this width method, or becomes a little broad towards the height direction, and the truck cross direction spreads on a target gradually. Or as shown in an alternate long and short dash line, said main pole layer 24 may consist of only front fields which maintain the width of recording track Tw, or become a little broad towards the height direction.
[0099] As shown in drawing 17 , the yoke layer 35 which connected magnetically on end face section 24b of said main pole layer 24 is formed in the configuration to which the dimension of the truck cross direction spreads on a target gradually towards the height direction back. In addition, narrow-width front field 35c shown by drawing 14 etc. may be formed in said opposed face H1a side of said yoke layer 35.
[0100] In addition, it does not pass over the configuration shown in drawing 17 to an example, and this invention is not limited to this configuration. Namely, in this invention, the area of the cross section which is when cutting said yoke layer 35 from a direction parallel to said opposed face H1a should just become larger than the area of front end side 24a of said main pole layer.
[0101] Drawing 6 is drawing of longitudinal section showing the structure of the vertical-magnetic-recording head of the 6th operation gestalt in this invention.
[0102] The difference from drawing 1 is in the structure of the main pole layer 24 and the yoke layer 35. In drawing 6 , the magnetic material layer 69 which the part of said main pole layer 24 and the part of said yoke layer 35 unified is formed on said insulating layer 33. As shown in drawing 6 , said magnetic material layer 69 consists of a main pole layer 24 of a front field, and a yoke layer 35 of the back field formed towards the height direction from the end face of said front field to predetermined die length from said opposed face H1a to the height direction back. It was formed in top-face 25a of said connection layer 25, and end face section 35b of the back field used as said yoke layer 35 has connected magnetically.
[0103] With this operation gestalt, as shown in drawing 6 , the thickness H10 of said yoke layer 35 is formed more thickly than the thickness H9 of said main pole layer 24.
[0104] Drawing 18 is the top view of the vertical-magnetic-recording head shown in drawing 6 . As shown in drawing 18 , the top face of front end side 24a of the main pole layer 24 is formed with the width of recording track Tw with the minute width method of the truck cross direction. Front field 24c which maintains this width method or becomes a little broad towards the height direction is formed, and said front field 24c has become the main pole layer 24. And the back end field used as the yoke layer 35 to which it applies in the height direction from the end face of said front field 24c, and the width method of the truck

cross direction spreads on a target gradually unifies, and is formed.
[0105] As mentioned above, although the structure of the operation gestalt of this invention shown in drawing 1 thru/or drawing 6 was explained, it is as follows when the focus in this invention is summarized.
[0106] (1) the above -- also in which operation gestalt, said main pole layer 24 is formed on the field by which flattening was carried out. Drawing 1 , drawing 2 , drawing 5 , and drawing 6 are formed on an insulating layer 33, and flattening of the top-face 33a of said insulating layer 33 is carried out by polish processing by a CMP technique etc. Moreover, in drawing 3 and drawing 4 , it is formed on the 4th insulating layer 57 and the yoke layer 35, and flattening of the top face of said 4th insulating layer 57 and the yoke layer 35 is carried out by polish processing of a CMP technique etc.
[0107] thus, in this invention, since said main pole layer 24 is formed on the flattening side with any operation gestalt, the pattern precision at the time of forming said main pole layer 24 is improved -- it can make -- said main pole layer 24 -- especially -- the top face of front end side 24a -- the minute width of recording track Tw -- accuracy -- and it can form easily. Therefore, in this invention, it can respond to narrow track-ization appropriately, and it is possible to manufacture the vertical-magnetic-recording head which can respond to future high recording density-ization. In addition, in this invention, as for said width of recording track Tw, it is desirable that it is 0.7 micrometers or less, and it is 0.5 micrometers or less more preferably.
[0108] (2) By this invention, the thickness of the yoke layer 35 can be formed with any operation gestalt more thickly than the thickness of the main pole layer 24. With the operation gestalt shown in drawing 1 thru/or drawing 5 , the main pole layer 24 and the yoke layer 35 are independently formed by each. Thus, by making the production process of the main pole layer 24 and the yoke layer 35 into another process, the thin main pole layer 24 of thickness and the thick yoke layer 35 of thickness can be formed easily, and said yoke layer 35 which therefore has the cross section larger enough than front end side 24a of said main pole layer 24 can be formed. Therefore, a record field can be drawn suitable for said main pole layer 24 from said yoke layer 35, and the passage effectiveness of magnetic flux becomes good and can improve an over-writing property.
[0109] Moreover, although the main pole layer 24 and the yoke layer 35 are formed in one with the operation gestalt shown in drawing 6 , also in this operation gestalt, it is possible to form the thickness of said yoke layer 35 more thickly than the thickness of said main pole layer 24 by preparing a level difference between said yoke layers 35 and main pole layers 24. In addition, about the manufacture approach, it mentions later.
[0110] (3) With the operation gestalt shown in drawing 1 thru/or drawing 5 , since the main pole layer 24 and the yoke layer 35 are independently formed by each, the truck width method of the main pole layer 24 can be set up as a thing different from the width method of said yoke layer 35.
[0111] Namely, in case of the configuration with which the main pole layer 24 and the yoke layer 35 were united like before The linear dimension to the height direction of the main pole layer 24 formed with the width of recording track Tw is shortened as much as possible. It becomes possible for the direction which forms the broad yoke layer 35 in the location from which it is not so much separated of distance in the height direction to be able to protect the magnetic saturation of said main pole layer 24 from said opposed face H1a, to be able to make said main pole layer 24 collect magnetic flux, and to obtain high recording density.
[0112] However, if the linear dimension to the height direction of said main pole layer 24 is shortened too much, from the problem of pattern precision, the predetermined width of recording track Tw will be hard to prescribe the width method of front end side 24a of said main pole layer 24, and it will become easy to generate dispersion in the width of recording track Tw or the configuration of the main pole layer 24.
[0113] On the other hand, when forming independently the main pole layer 24 and the yoke layer 35 like this invention, for example, as shown in drawing 12 or drawing 17 Even if it forms narrow-width front field 24c formed with the width of recording track Tw of said main pole layer 24 for a long time Since it becomes possible to lay said yoke layer 35 on top of the front field 24c top of said main pole layer 24, or the bottom, and to bring close and form said yoke layer 35 in said opposed face H1a side While being able to aim at concentration of magnetic flux, it becomes possible for pattern precision to be good and to form said main pole layer 24 with the predetermined width of recording track Tw. Moreover, the degree of freedom of a design of the main pole layer 24 and the yoke layer 35 increases.
[0114] Therefore, when forming the yoke layer 35 on 24d of broad back fields formed in the main pole layer 24 in the case of drawing 1 as shown in drawing 10 if it carries out from the above-mentioned viewpoint, front field 24c of said main pole layer 24 must be made short to L1, and it becomes easy to generate

dispersion in the width of recording track Tw or a configuration. For this reason, if the perimeter of said main pole layer 24 is fill uped with the 2nd insulating layer 56 and flattening of said main pole layer 24 and 2nd insulating layer 56 is carried out with a CMP technique as shown in drawing 11 and drawing 12 Since it becomes possible to form the yoke layer 35 on the 2nd insulating layer 56 by which flattening was carried out As shown in drawing 12 , the yoke layer 35 can be piled up on front field 24c of the main pole layer 24, therefore, front field 24c of said main pole layer 24 is extended for a long time to L2, pattern precision is raised, and it becomes possible to form with the predetermined width of recording track Tw.

[0115] (4) With any operation gestalt of this invention, as shown in drawing 7 R> 7 and drawing 8 (all are front views), it is the inclined plane or bow side where the width method to the truck cross direction (the direction of graphic display X) spreads [the side sides 24g and 24g of front end side 24a of the main pole layer 24] towards an underside to a top face. And the top face (end face by the side of trailing of the main pole layer 24) of front end side 24a of said main pole layer 24 is regulated as the width of recording track Tw.

[0116] Thus, if the side sides 24g and 24g of front end side 24a of said main pole layer 24 are made into an inclined plane or a bow side and the configuration of said front end side 24a is substantially inverted trapezoidal [-like] Even if it produces an angle of skew as the broken line of drawing 9 shows when said **** medium records by running to a graphic display Z direction, 24g of said side sides shown by (iii) does not overflow aslant the recording track width of face Tw1 into the side greatly. Therefore, fringing by 24g of said side sides can be prevented now, and improvement in the off-track engine performance can be aimed at.

[0117] Moreover, as shown in the dotted line of drawing 7 and drawing 8 , although the top faces 33a and 57b of the insulating layers 33 and 57 currently formed in the underside both sides of said main pole layer 24 are inclining or curving in the direction of an underside as they separate from the main pole layer 24, they depend this on the effect of etching at the time of removing said insulating layers 33 other than under said main pole layer 24, and the excessive plating substrate layer 71 formed on 57.

[0118] (5) When forming independently the main pole layer 24 and the yoke layer 35 like the operation gestalt shown in drawing 1 thru/or drawing 5 , it is possible to form the main pole layer 24 with the magnetic material which has saturation magnetic flux density higher than said yoke layer 35.

[0119] This sometimes gives the magnetic flux phi with a high consistency perpendicularly possible to the hard side Ma of a record medium M from front end side 24a of said main pole layer 24 with the cross section of the truck cross direction smaller than said yoke layer 35, and an over-writing property can be raised.

[0120] With this vertical-magnetic-recording head H, if a record current is given to the coil layer 27 through the lead layer 36, a record field will be guided to the auxiliary magnetic pole layer 21 and the yoke layer 35 by the current field of the current which flows the coil layer 27. As shown in each operation gestalt, in opposed face H1a, the leakage record field from front end side 24a of said main pole layer 24 and front end side 21b of the auxiliary magnetic pole layer 21 penetrates the hard side Ma of a record medium M, and passes through the software side Mb. Since the area of front end side 24a of said main pole layer 24 is smaller enough than the area of front end side 21b of the auxiliary magnetic pole layer 21, it leaks to front end side 24a of said main pole layer 24, the magnetic flux phi of a record field concentrates, said hard side Ma is perpendicularly magnetized by this magnetic flux phi currently concentrated, and magnetic data are recorded.

[0121] Next, the manufacture approach of the vertical-magnetic-recording head of each operation gestalt is explained below. Drawing 19 thru/or drawing 21 are the common production processes of each operation gestalt. In addition, 1 process drawing showing in drawing 3232 from drawing 19 shows drawing of longitudinal section of a vertical-magnetic-recording head.

[0122] At the process shown in drawing 19 , after forming the auxiliary magnetic pole layer 21 made from a magnetic material on the nonmagnetic insulating layer 12, the height direction back of said auxiliary magnetic pole layer 21 is also fill uped with said nonmagnetic insulating layer 12, and carries out flattening processing of the top face of said auxiliary magnetic pole layer 21 and the nonmagnetic insulating layer 12 using a CMP technique etc. further.

[0123] Next, behind [height direction] said auxiliary magnetic pole layer 21, plating formation of the connection layer 25 made from a magnetic material is carried out, it applies to the top face of the connection layer 25 from said auxiliary magnetic pole layer 21 top face further, the spatter of the inorganic insulating material is carried out, and the nonmagnetic insulating layer 26 is formed in it.

[0124] Next, as shown in drawing 20 , the coil layer 27 is formed with frame plating on said nonmagnetic

insulating layer 26, and similarly the bottom raising layer 31 is further formed by plating. The coil layer 27 is formed in a location lower enough than the height of said connection layer 25 at this time. And the spatter of the inorganic insulating material is carried out for said coil layer 27 and the bottom raising layer 31 to a bonnet and a pan by the insulating layer 32 of an organic material, and the wrap insulating layer 33 is formed for all layers.

[0125] Next, polish processing is performed from the graphic display upper part to each class formed by the condition of drawing 20 using a CMP technique etc. This polish processing is performed to the location of the level surface (L-L side) which crosses all said insulating layers 33, the connection layers 25, and bottom raising layers 31.

[0126] As a result of said polish processing, as shown in drawing 21 , it is processed so that all of surface 25a of the connection layer 25, surface 33a of an insulating layer 33, and surface 31a of the bottom raising layer 31 may become the same field.

[0127] It is the production process in which even this is common in each operation gestalt. Next, the manufacture approach of the vertical-magnetic-recording head of the structure shown in drawing 1 is explained.

[0128] At the process shown in drawing 22 , the resist layer 60 is first formed in top-face 33a of said insulating layer 33, top-face 25a of the connection layer 25, and the whole top-face 31a of the bottom raising layer 31, by exposure development, the main pole layer 24 extracts and pattern 60a is formed. The aforementioned omission pattern 60a is formed even in top-face 25a of said connection layer 25 from opposed face H1a with a record medium. Moreover, it extracts, even if it applies to the height direction (direction of graphic display Y) back from top-face 31a of said bottom raising layer 31, and a pattern is formed. And in the aforementioned omission pattern 60a, plating formation of the main pole layer 24 is carried out, and the account resist layer 60 of back to front is removed. The main pole layer 24 prolonged from said opposed face H1a to the connection layer 25 by this is formed. In addition, since it is covered with the plating substrate layer at the time of said main pole layer 24 formation (not shown) all over the insulating layer 33, it leaves said plating substrate layer formed in the bottom of said main pole layer 24, and other plating substrate layers are removed by etching. Although said main pole layer 24 is also deleted in part at this time, thereby, the width of recording track Tw of the top face (end face by the side of trailing) of said main pole layer 24 becomes narrow, and it becomes possible to manufacture the vertical-magnetic-recording head which can respond to narrow track-ization.

[0129] Next, at the process shown in drawing 23 , the resist layer 61 is formed the whole surface on said main pole layer 24 and an insulating layer 33. Let said resist layer 61 be thickness thicker than said main pole layer 24. Then, by exposure development, the yoke layer 35 extracts and pattern 61a is formed. It is made for front end side 61b of the aforementioned omission pattern 61a to be located in the height direction back rather than opposed face H1a with a record medium at this time. And plating formation of the yoke layer 35 is carried out into the aforementioned omission pattern 61a, and the account resist layer 61 of back to front is removed. The yoke layer 35 of thickness thicker than said main pole layer 24 piles up on said main pole layer 24 by this.

[0130] In addition, since it is unnecessary in said plating substrate layer like drawing 10 to form said yoke layer 35 only on the main pole layer 24, it is unnecessary in the clearance process of said plating substrate layer.

[0131] Moreover, in the case of drawing 11 and drawing 12 , after covering the perimeter of said main pole layer 24 by the 2nd insulating layer 56 of an inorganic insulating material, the top face of said main pole layer 24 and the top face of said 2nd insulating layer 56 are processed on the same flattening side using a CMP technique. Then, as shown in the process of drawing 23 , plating formation of the yoke layer 35 is carried out in piles on said main pole layer 24. At this time, the width method in the truck cross direction of said yoke layer 35 may be broader than the width method of said main pole layer 24 and said main pole layer in the piled-up location. Moreover, in this case, it is not necessary to extend said main pole layer 24 for a long time, and to form it even on the connection layer 25, and said main pole layer 24 can be formed with a short linear dimension so that it may be shown at the time of drawing 2222 process. Moreover, end face section 35b of said yoke layer 35 is formed in top-face 25a of said connection layer 25 in this case, and end face section 35b of said yoke layer 35 and the connection layer 25 are connected magnetically.

[0132] In addition, although the resist layer 61 left behind to the opposed face H1a side rather than front end side 61b of the aforementioned omission pattern 61a is formed in respect of the inclined plane which the back end side 61c is missing from a top face from an underside, and becomes deep gradually in the height direction, or the bow as shown in drawing 23 This can be attained by using the resist layer 61 which changes

the class of resist layer 61, leaves the part by which exposure development was carried out, and can remove the part by which exposure development is not carried out. Moreover, it can form in the inclined plane or bow side which inclines in the height direction (the direction of graphic display Y), applying front end side 35a of said yoke layer 35 to a top face from an underside by this.

[0133] The vertical-magnetic-recording head shown in drawing 1 according to the above-mentioned process is completed. Drawing 24 and drawing 25 are 1 process drawings of the manufacture approach of the vertical-magnetic-recording head shown in drawing 2 .

[0134] At the process shown in drawing 24 , the resist layer 62 is formed in top-face 33a of said insulating layer 33, top-face 25a of the connection layer 25, and the whole top-face 31a of the bottom raising layer 31, by exposure development, the main pole layer 24 extracts and pattern 62a is formed. The aforementioned omission pattern 62a is formed in the height direction (direction of graphic display Y) back by short die length from said opposed face H1a. And after carrying out plating formation of the main pole layer 24 into the aforementioned omission pattern 62a, said resist layer 62 is removed.

[0135] Next, at the process shown in drawing 25 , after forming the resist layer 63 the whole surface on said main pole layer 24 and an insulating layer 33, the yoke layer 35 extracts in said resist layer 63, and pattern 63a is formed. In addition, the thickness of said resist layer 63 is formed more thickly than the thickness of said main pole layer 24. Moreover, said resist layer 63 extracts and it is made for front end side 63b of pattern 63a to be located in 24f of back end sides of said main pole layer 24. Furthermore, the aforementioned omission pattern 63a is formed even on the connection layer 25. And plating formation of the yoke layer 35 is carried out into the aforementioned omission pattern 63a, and said resist layer 63 is removed after that.

[0136] Thereby, the yoke layer 35 with larger thickness than said main pole layer 24 can be formed from 24f of back end sides of said main pole layer 24. Moreover, said yoke layer 35 is magnetically connected on said connection layer 25. In addition, since it is covered with the plating substrate layer (not shown) all over the insulating layer 33, it leaves said plating substrate layer formed in the bottom of said main pole layer 24, and other plating substrate layers are removed by etching. Although said main pole layer 24 is also deleted in part at this time, thereby, the width of recording track Tw of said main pole layer 24 becomes narrow, and it becomes possible to manufacture the vertical-magnetic-recording head which can respond to narrow track-ization.

[0137] Moreover, by this manufacture approach, since the main pole layer 24 is only put to 1 time of an etching process while the clearance process of said plating substrate layer can be managed with 1 time after yoke layer 35 formation and being able to simplify a production process, narrow track-ization is realizable, keeping large the height dimension of said main pole layer 24.

[0138] The vertical-magnetic-recording head shown in drawing 2 according to the above-mentioned process is completed. the process shown in drawing 26 thru/or drawing 28 -- drawing 3 R> -- it is 1 process drawing showing the production process of the vertical-magnetic-recording head shown in 3 and 4.

[0139] At the process shown in drawing 26 , the resist layer 64 is formed in top-face 33a of said insulating layer 33, top-face 25a of the connection layer 25, and the whole top-face 31a of the bottom raising layer 31, by exposure development, the yoke layer 35 extracts and pattern 64a is formed.

[0140] As shown in drawing 26 , front end side 64b of the aforementioned omission pattern 64a is formed in the height direction back side rather than said opposed face H1a. Moreover, although said front end side 64b and back end side 64c of the resist layer 64 left behind among said opposed face H1a are the inclined plane which is missing from a top face from an underside, and inclines to said opposed face H1a side, it is possible to form by this inclined plane's heat-treating in said resist layer 64, and making whom generate. Moreover, the aforementioned omission pattern 64a is formed even on said connection layer 25.

[0141] And plating formation of the yoke layer 35 is carried out into the aforementioned omission pattern 64a, and the account resist layer 64 of back to front is removed. Front end side 35a can form said yoke layer 35 located in the height direction back side rather than said opposed face H1a by this. Moreover, as for said front end side 35a, it is desirable that it is the inclined plane or bow side which is missing from a top face from an underside, and inclines to the height direction back. Moreover, as for the exterior angle theta between said inclined plane 35a and top faces, it is desirable that it is 90 degrees or more. Moreover, said yoke layer 35 has connected magnetically on said connection layer 25.

[0142] In addition, after removing said resist layer 63, the plating substrate layer (not shown) formed in parts other than under said yoke layer 35 is removed by etching.

[0143] Next, at the process shown in drawing 27 , the 4th insulating layer 57 by the inorganic insulating material is formed on said yoke layer 35 and an insulating layer 33. Polish processing of said 4th insulating

layer 57 is carried out with a CMP technique from the M-M line furthermore shown in drawing 27 , and, thereby, the top face of said 4th insulating layer 57 and the top face of the yoke layer 35 are made in the same flattening side.
[0144] Next, at the process shown in drawing 28 , the resist layer 65 is formed on said 4th insulating layer 57 and said yoke layer 35, the main pole layer 24 extracts in said resist layer 65, and pattern 65a is formed.
[0145] As shown in drawing 28 , thickness of said resist layer 65 is made smaller than the thickness of said yoke layer 35, moreover said resist layer 65 extracts, and front end side 65b of pattern 65a is formed so that it may become the same field as opposed face H1a. If it forms even on the same field as the back end side of the yoke layer 35 like drawing 28 about back end side 65c of the aforementioned omission pattern 65a, the configuration of the main pole layer 24 can be formed like drawing 3 , and if back end side 65c of the aforementioned omission pattern 65 is short formed in the opposed face H1a side, the configuration of said main pole layer 24 can be formed like drawing 4 .
[0146] And plating formation of the main pole layer 24 is carried out into the aforementioned omission pattern 26, and the account resist layer 65 of back to front is removed. Thereby, front end side 24a appears in opposed face H1a, and thickness can form the main pole layer 24 thinner than the yoke layer 35 in piles on said yoke layer 35.
[0147] In addition, since it is covered with the plating substrate layer (not shown) of said main pole layer 24 all over the 4th insulating layer 57 and the yoke layer 35, it leaves said plating substrate layer formed in the bottom of said main pole layer 24, and other plating substrate layers are removed by etching. Although said main pole layer 24 is also deleted in part at this time, thereby, the width of recording track Tw of said main pole layer 24 becomes narrow, and it becomes possible to manufacture the vertical-magnetic-recording head which can respond to narrow track-ization.
[0148] The vertical-magnetic-recording head shown in drawing 3 or drawing 4 according to the above-mentioned process is completed. Next, the manufacture approach of the vertical-magnetic-recording head shown in drawing 5 is explained using process drawing of drawing 29 thru/or drawing 32 .
[0149] At the process shown in drawing 29 , the resist layer 66 is formed in top-face 33a of said insulating layer 33, top-face 25a of the connection layer 25, and the whole top-face 31a of the bottom raising layer 31, by exposure development, the main pole layer 24 extracts and pattern 66a is formed. The aforementioned omission pattern 66a is formed in the height direction (direction of graphic display Y) back by short die length from said opposed face H1a. And after carrying out plating formation of the main pole layer 24 into the aforementioned omission pattern 66a, said resist layer 66 is removed. In addition, since it is covered with the plating substrate layer (not shown) all over the insulating layer 33, it leaves said plating substrate layer formed in the bottom of said main pole layer 24, and other plating substrate layers are removed by etching. Although said main pole layer 24 is also deleted in part at this time, thereby, the width of recording track Tw of said main pole layer 24 becomes narrow, and it becomes possible to manufacture the vertical-magnetic-recording head which can respond to narrow track-ization.
[0150] Next, at the process shown in drawing 30 , the 3rd insulating layer 58 of the thin thickness by inorganic insulating materials, such as aluminum 2O3 and SiO2, is formed in the whole surface on said main pole layer 24 and an insulating layer 33.
[0151] Next, at the process shown in drawing 31 , using a resist layer (not shown), said a part of 3rd insulating layer 58 is removed, and Holes 58a and 58b are formed. Said one hole 58a is formed on end face section 24b of said main pole layer 24. Moreover, hole 58b of another side is formed on the connection layer 25.
[0152] Next, at the process shown in drawing 32 , the resist layer 67 of thickness thicker than said main pole layer 24 is formed on said 3rd insulating layer 58, the yoke layer 35 extracts in said resist layer 67, and pattern 67a is formed by exposure development.
[0153] As shown in drawing 32 , front end side 67b of the aforementioned omission pattern 67a is formed in the height direction back side rather than opposed face H1a, and the aforementioned omission pattern 67a is extended and formed even on said connection layer 25.
[0154] In addition, although the resist layer 67 left behind to the opposed face H1a side rather than front end side 67b of the aforementioned omission pattern 67a is formed in respect of the inclined plane which the back end side 67c is missing from a top face from an underside, and becomes deep gradually in the height direction, or the bow as shown in drawing 32 This can be attained by using the resist layer 67 which changes the class of resist layer 67, leaves the part by which exposure development was carried out, and can remove the part by which exposure development is not carried out.
[0155] And plating formation of the yoke layer 35 is carried out into the aforementioned omission pattern

67a, and said resist layer 67 is removed. Thereby, said front end side 35a is located in the height direction back side, and can form the yoke layer 35 with thickness thicker than said main pole layer 24.
[0156] In addition, said yoke layer 35 is magnetically connected like drawing 32 , respectively on end face section 24b of said main pole layer 24, and the connection layer 25. Moreover, after removing said resist layer 67, the plating substrate layer (not shown) formed in parts other than under said yoke layer 35 is removed by etching. Since the top face of said main pole layer 24 is protected by the 3rd insulating layer 58 at this time, it is avoidable that said main pole layer 24 is deleted at said etching process.
[0157] The vertical-magnetic-recording head shown in drawing 5 according to the above-mentioned process is completed. Next, the manufacture approach of the vertical-magnetic-recording head shown in drawing 6 is explained using drawing 33 and drawing 34 .
[0158] At the process shown in drawing 33 , the resist layer 68 is formed in top-face 33a of said insulating layer 33, top-face 25a of the connection layer 25, and the whole top-face 31a of the bottom raising layer 31, by exposure development, the magnetic material layer 69 extracts and pattern 68a is formed. As shown in drawing 33 , front end side 68b of the aforementioned omission pattern 68a is formed on the same field as said opposed face H1a, and the aforementioned omission pattern 68a is extended and formed even on said connection layer 25.
[0159] And plating formation of the magnetic material layer 69 is carried out into the aforementioned omission pattern 68a, and said resist layer 68 is removed. In addition, since it is covered with the plating substrate layer (not shown) all over the insulating layer 33, it leaves said plating substrate layer formed in the bottom of said magnetic material layer 69, and other plating substrate layers are removed by etching.
[0160] As shown in drawing 33 , the front end side 69a appeared in said opposed face H1a, and end face section 69b will be magnetically connected by said magnetic material layer 69 on said connection layer 25.
[0161] Next, at the process shown in drawing 34 , the resist layer 70 is formed on said magnetic material layer 69, on the front of said magnetic material layer 69, it extracts for main pole layer 24 formation, and pattern 70a is formed by exposure development.
[0162] Next, a part of magnetic material layer 69 exposed under the aforementioned omission pattern 70a is removed by etching (dotted-line part). The thickness of the magnetic material layer 69 left behind by this to the bottom of the aforementioned omission pattern 70a becomes thin, this part serves as the main pole layer 24, and is not etched, but the thick magnetic material layer 69 of thickness turns into the yoke layer 35, and the vertical-magnetic-recording head of drawing 6 with which said main pole layer 24 and yoke layer 35 were united completes it. In addition, since plating substrate layers other than under the magnetic material layer 69 are beforehand removed after forming the thick magnetic material layer 69 of thickness by this manufacture approach, the 3rd insulating layer 58 for protecting said main pole layer 24 so that the main pole layer 24 may not be deleted at the etching process of yoke layer 35 formation like the production process of drawing 29 thru/or drawing 32 R> 2 is able to simplify a production process, such as being unnecessary, for example.
[0163] The width of recording track Tw of said main pole layer 24 can be made small by etching at the time of being able to form said main pole layer 24 with a sufficient pattern precision, and removing a plating substrate layer by any above-mentioned manufacture approach, since said main pole layer 24 can be formed on a flattening side, and the vertical-magnetic-recording head which can respond to narrow track-ization accompanying a raise in future recording density can be manufactured.
[0164] Moreover, at the process shown in drawing 22 thru/or drawing 32 , since the main pole layer 24 and the yoke layer 35 can be formed at another process, thickness at the time of said yoke layer 35 formation is made thicker than the thickness at the time of main pole layer 24 formation, and the thickness of said yoke layer 35 can be easily formed greatly rather than the thickness of the main pole layer 24. Moreover, if the manufacture approach of this invention is used also when really forming the main pole layer 24 and the yoke layer 35, as shown in drawings 3333 and 34, thickness of said yoke layer 35 can be made thicker than the thickness of said main pole layer 24.
[0165] Furthermore by manufacturing at a separate process, said main pole layer 24 and yoke layer 35 The width of recording track Tw of the main pole layer 24 can be set up as a thing different from the width method of said yoke layer 35. Since said yoke layer 35 can be freely formed in the location near opposed face H1a in the case of the structure of piling up the main pole layer 24 and the yoke layer 35 by the upper and lower sides like especially drawing 1 , and 3 and 4, The linear dimension to the height direction of said main pole layer 24 can be formed for a long time conventionally, it is the predetermined width of recording track Tw, and moreover, it varies in a configuration and said main pole layer 24 can be formed that there is nothing.

[0166] Although the manufacture approach of the vertical-magnetic-recording head shown in drawing 1 thru/or drawing 6 as mentioned above was explained, below, the formation approach of front end side 24a of said main pole layer 24 in this invention is explained. Although drawing 35 thru/or drawing 37 are front views and being typically explained using the production process (drawing 22) of the vertical-magnetic-recording head of drawing 1 , it is applicable to any production process of drawing 2 thru/or the vertical-magnetic-recording head of drawing 6 .
[0167] Drawing 35 is the partial front view of the vertical-magnetic-recording head at the time of the production process shown in drawing 22 . At the process shown in drawing 22 , after forming the plating substrate layer 71 of said main pole layer 24, the resist layer 60 is formed on this.
[0168] Next, it extracts for main pole layer 24 formation by exposure development in said resist layer 60, and pattern 60a is formed. Then, it heat-treats and the inside end face of said resist layer 60 is produced for whom (see the dotted line). Thereby, the inside end face of the aforementioned omission pattern 60a turns into the inclined plane or bow side where it applies to a top face from an underside, and the width method of the truck cross direction (the direction of graphic display X) spreads.
[0169] And like the process shown in drawing 36 , plating formation of the main pole layer 24 is carried out into the aforementioned omission pattern 60a, and said resist layer 60 is removed. The condition is drawing 37 , and as shown in drawing 37 , the inclined plane or bow side where it applies to a top face from an underside, and a width method spreads the both-sides side sides 24g and 24g of the truck cross direction of said main pole layer 24 is formed.
[0170] Next, plating substrate layers 71 other than plating substrate layer 71 formed in said main pole layer 24 bottom are removed in anisotropic etching. In addition, as for said etching include angle, it is desirable to lean around 70 degrees at 45 degrees or more to a perpendicular direction. Unnecessary plating substrate layer 71a is removed by this etching process. Moreover, the main pole layer 24 is also deleted in part according to said etching process.
[0171] As shown in drawing 37 , by deleting the both-sides side sides 24g and 24g of said main pole layer 24, the width of recording track Tw regulated by the width method of the top face of said main pole layer 24 becomes small (a dotted line shows), and can manufacture the vertical-magnetic-recording head which can respond to narrow track-ization.
[0172] In addition, since it extends a little to the perimeter under said main pole layer 24 and said plating substrate layer 71 may be left behind when nonmagnetic, for example, metallic materials, such as Cu, is used for said plating substrate layer 71, etching control can be simplified compared with the case where a magnetic metallic material is used for said plating substrate layer 71.
[0173] Moreover, there is also a method of not using drawing 35 and a resist layer 60 like drawing 36 at the time of formation of said main pole layer 24. This forms the layer of an inorganic insulating material on said plating substrate layer 71, after forming said plating substrate layer 71 with a non-magnetic metal ingredient. The resist layer in which predetermined spacing was furthermore vacated on the layer of said inorganic insulating material is formed, and etching removes the layer of said inorganic insulating material exposed out of said spacing. The both-sides end face of the truck cross direction in the removed space is formed in the configuration in which it applies to a top face from an underside, and a width method spreads, and carries out plating formation of the main pole layer 24 into this space. It is possible to form the main pole layer 24 in which the inclined plane or bow side where this is missing from a top face from an underside the both-sides side sides 24g and 24g of the truck cross direction, and a width method spreads was formed.
[0174] In addition, in this invention, the inclined plane which can keep setting to the height direction back rather than said opposed face, and is shown in drawing 3636 at the inner end face of the both sides of a pattern that said resist layer 60 should just be formed so that it may spread at least as the inside width method of the truck cross direction in said opposed face H1a separates from said auxiliary magnetic pole layer 21 does not need to be formed.
[0175] Moreover, with the operation gestalt shown in drawing 1 thru/or drawing 6 , although read station HR is formed, this does not need to be formed.
[0176]
[Effect of the Invention] as mentioned above, by this invention, since a main pole layer is formed on the field by which flattening was carried out, the pattern precision at the time of forming said main pole layer is improved -- it can make -- said main pole layer -- especially -- a front end side -- the minute width of recording track Tw -- accuracy -- and it can form easily. Therefore, in this invention, it can respond to narrow track-ization appropriately, and it is possible to manufacture the vertical-magnetic-recording head

which can respond to future high recording density-ization.
[0177] Moreover, in this invention, the thickness of a yoke layer can be formed more thickly than the thickness of a main pole layer, and said yoke layer which has the cross section larger enough than the front end side of said main pole layer can be formed. Therefore, a record field can be drawn suitable for said main pole layer from said yoke layer, and the passage effectiveness of magnetic flux becomes good and can improve an over-writing property.
[0178] By moreover, the thing for which a main pole layer and a yoke layer are formed independently, and said yoke layer is laid on top of said main pole layer top or the bottom Since it becomes possible to bring said yoke layer close freely and to form it in an opposed face side with a record medium even if it forms the narrow-width field formed with the width of recording track Tw of said main pole layer for a long time While being able to aim at concentration of magnetic flux, it becomes possible for pattern precision to be good and to form said main pole layer with the predetermined width of recording track Tw.
[0179] Furthermore, by this invention, even if the side side of the front end side of a main pole layer serves as the inclined plane or bow side where the width method to the truck cross direction spreads towards a top face from the underside and produces an angle of skew by this at the time of record, it can prevent fringing now and can aim at improvement in the off-track engine performance.

[Translation done.]

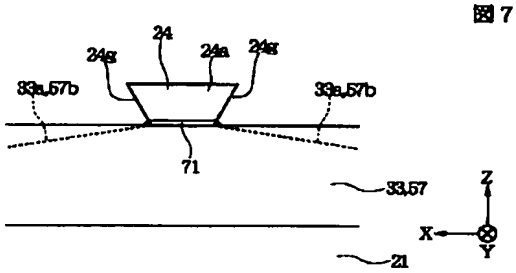
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

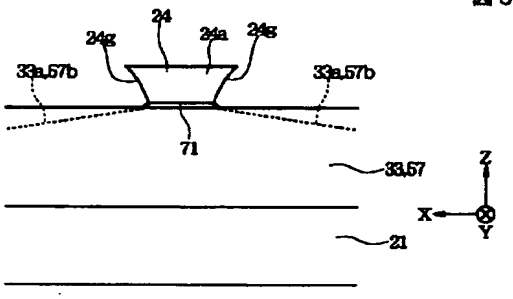
[Drawing 7]

図7



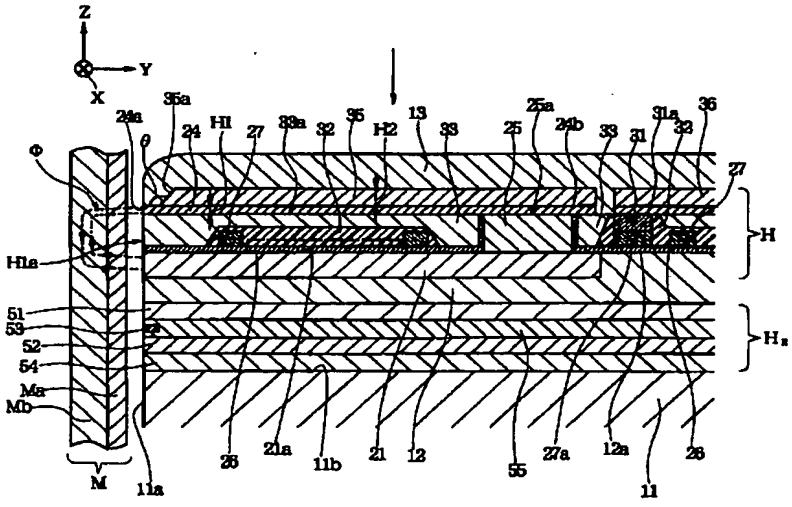
[Drawing 8]

図8



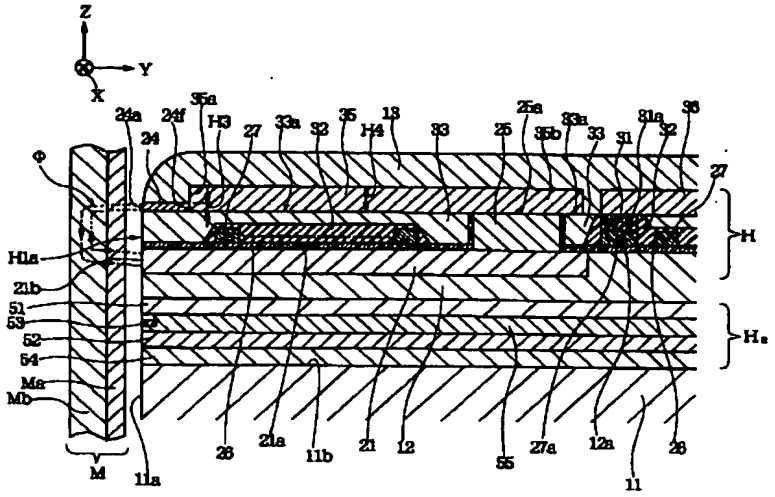
[Drawing 1]

図1



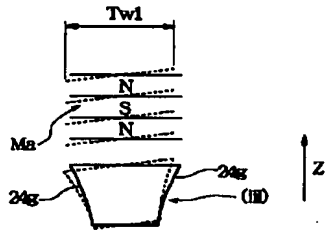
[Drawing 2]

図 2



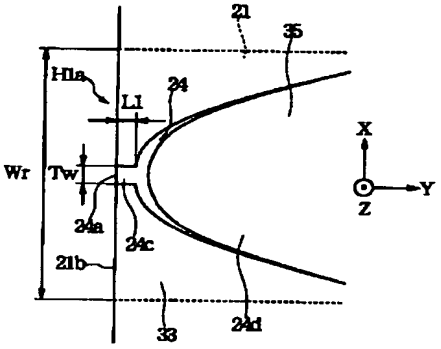
[Drawing 9]

図 9



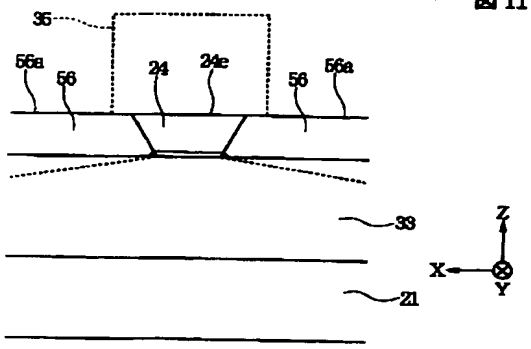
[Drawing 10]

図 10



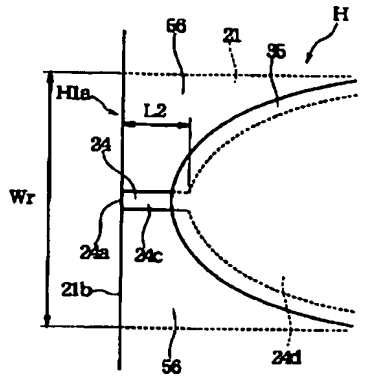
[Drawing 11]

図 11



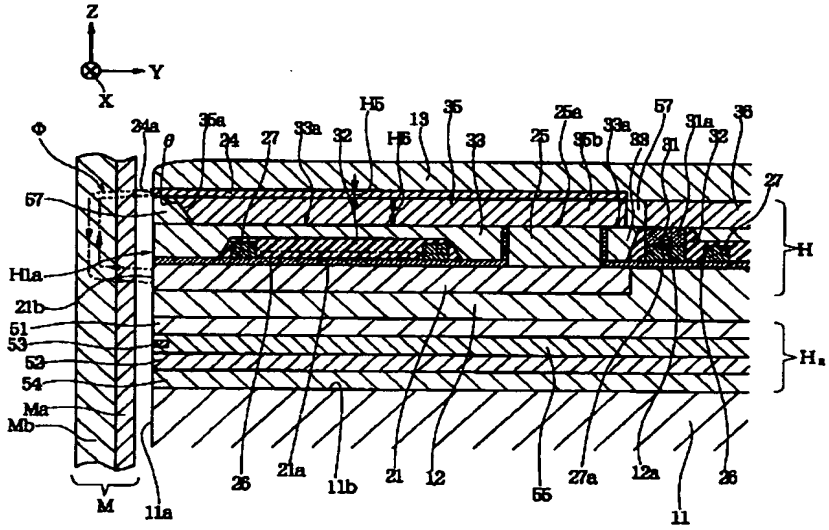
[Drawing 12]

図 12



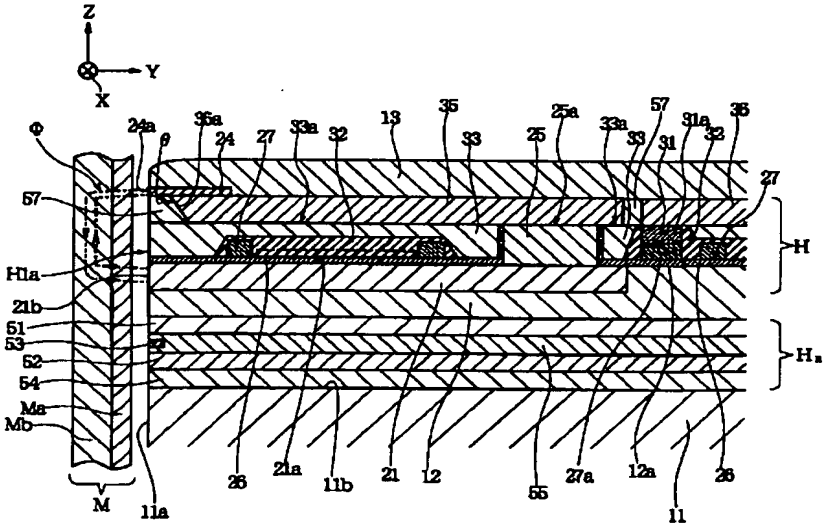
[Drawing 3]

図 3



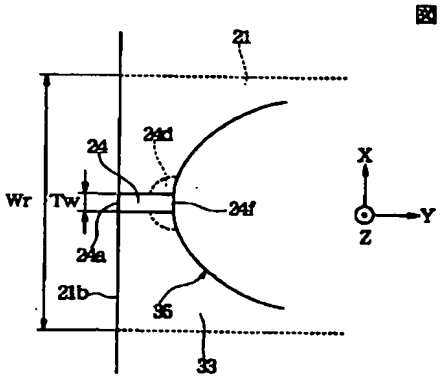
[Drawing 4]

図 4



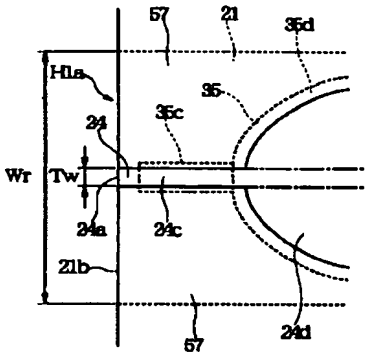
[Drawing 13]

図 13



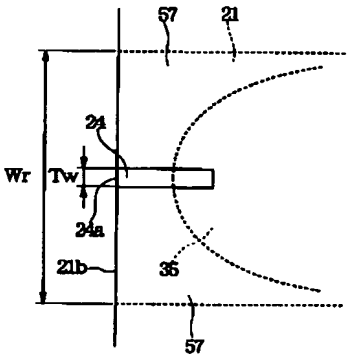
[Drawing 14]

図 14



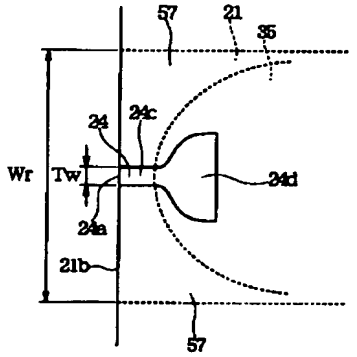
[Drawing 15]

図 15



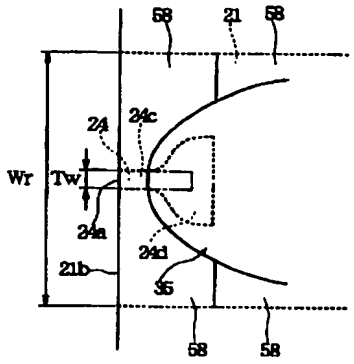
[Drawing 16]

図 16



[Drawing 17]

図 17



[Drawing 21]

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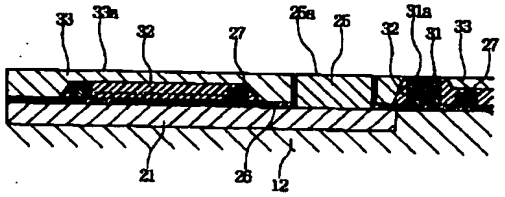
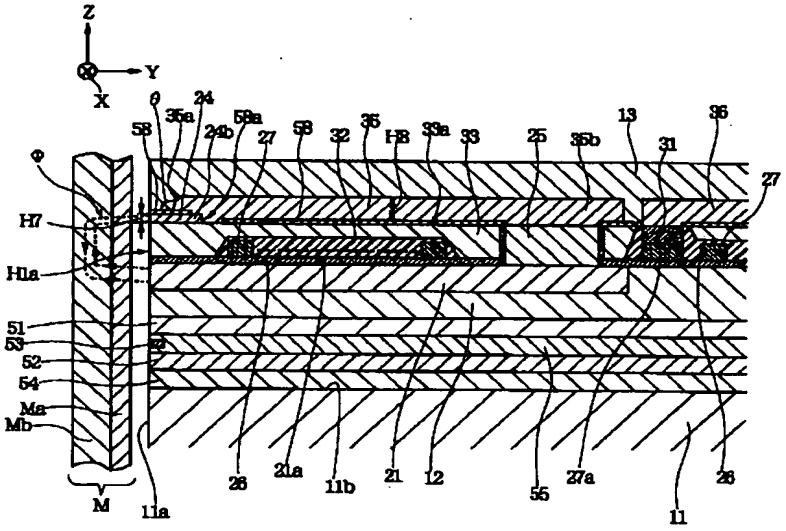


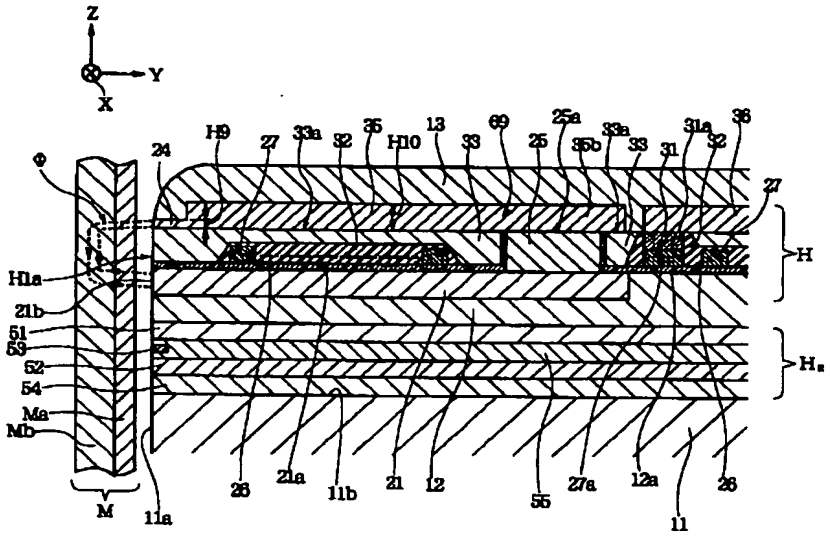
[Drawing 5]

図 5



[Drawing 6]

図 6



[Drawing 18]

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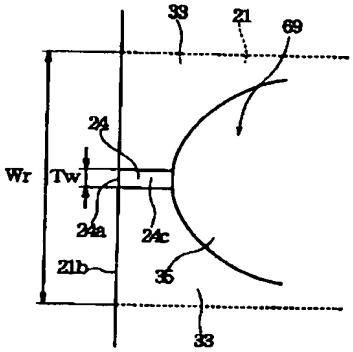

[Drawing 19]

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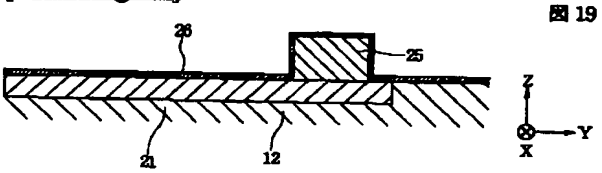

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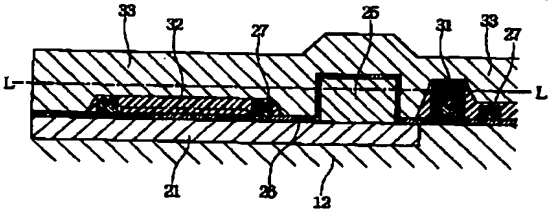
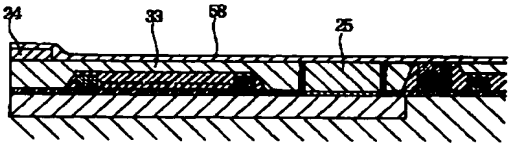


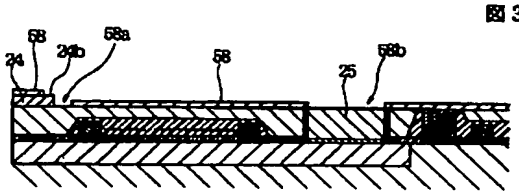
[Drawing 30]

図 30



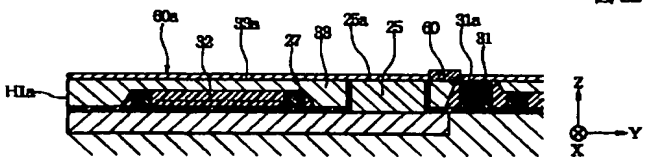
[Drawing 31]

図 31



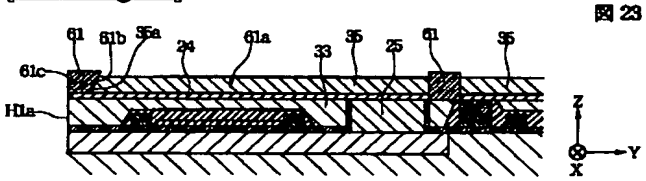
[Drawing 22]

図 22



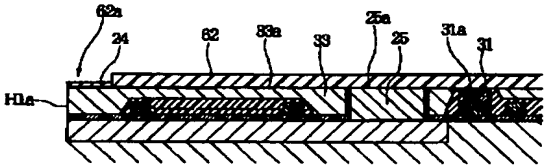
[Drawing 23]

図 23



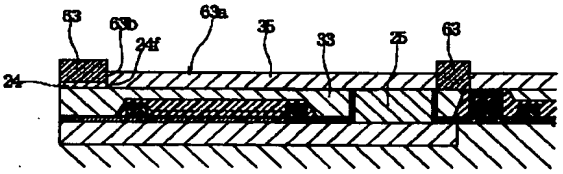
[Drawing 24]

図 24



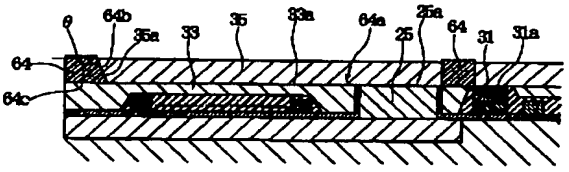
[Drawing 25]

図 25



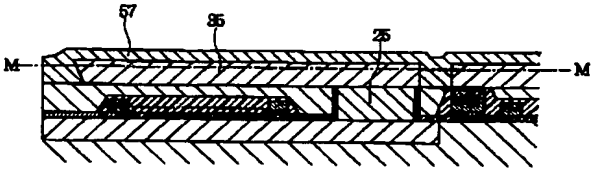
[Drawing 26]

図 26



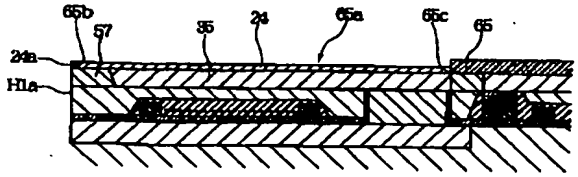
[Drawing 27]

図 27



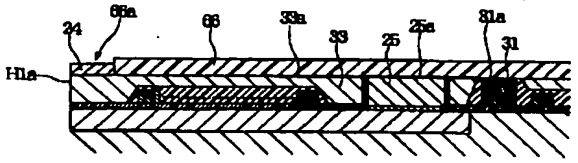
[Drawing 28]

図 28



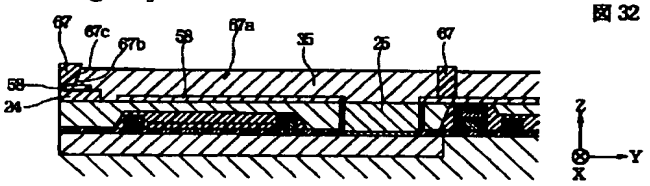
[Drawing 29]

図 29



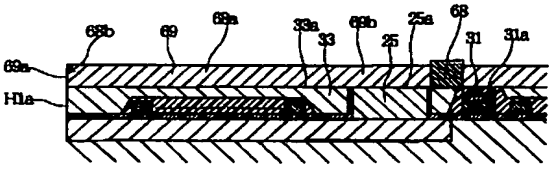
[Drawing 32]

図 32



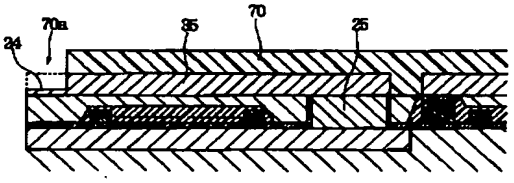
[Drawing 33]

図 33



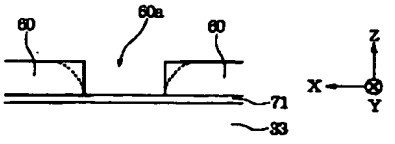
[Drawing 34]

図 34



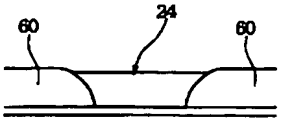
[Drawing 35]

図 35



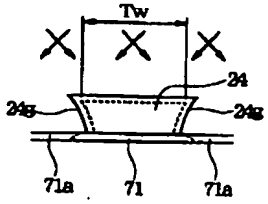
[Drawing 36]

図 36



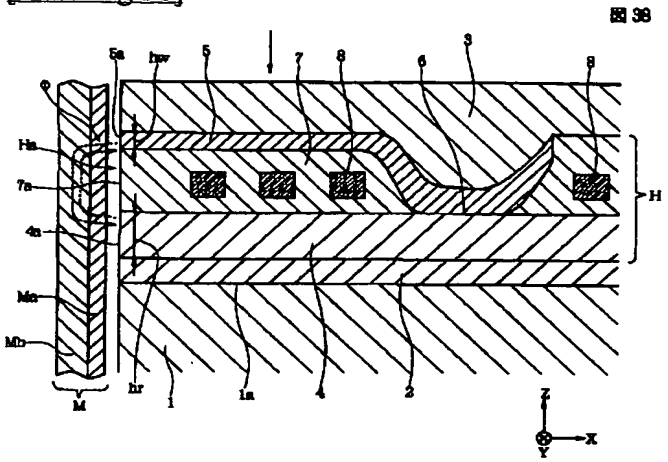
[Drawing 37]

図 37



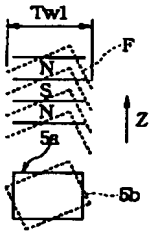
[Drawing 38]

図 38



[Drawing 39]

図 39



[Translation done.]

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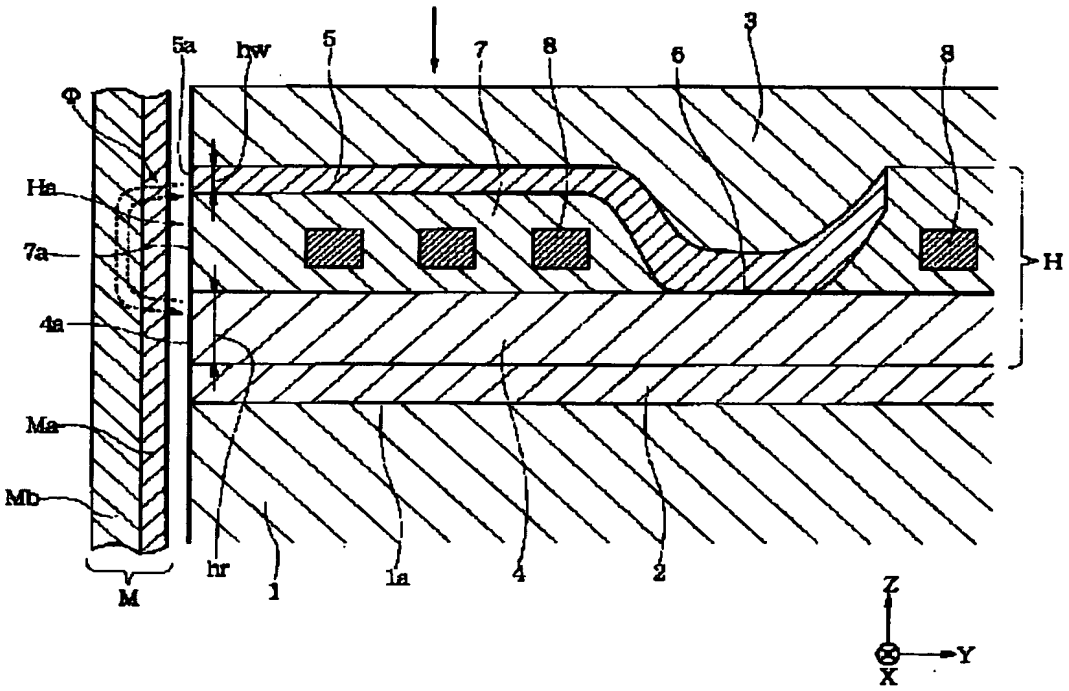
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

WRITTEN AMENDMENT

---------- [procedure amendment]
[Filing Date] February 15, Heisei 14 (2002. 2.15)
[Procedure amendment 1]
[Document to be Amended] DRAWINGS
[Item(s) to be Amended] drawing 38
[Method of Amendment] Modification
[Proposed Amendment]
[Drawing 38]

図 38



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